Totally videoendoscopic descending thoracic aorta-to-femoral artery bypass

Sumio Fukui, MD,[a] **Nikolaos Paraskevas, MD,**[b] **Patrick Soury, MD,**[c] and **Frédéric Gigou, MD,**[d] *Paris, Trappes, and Meaux, France; and Athens, Greece*

Descending thoracic aorta to femoral artery bypass is an effective and safe procedure for the treatment of aortoiliac occlusive disease when an approach to the abdominal aorta is undesirable. The major limitation of this technique has resulted from the morbidity rate associated with thoracotomy in a relatively high-risk vascular surgery population. As a minimally invasive procedure, videoendoscopy has been shown to improve the patient postoperative course and comfort in the field of general and thoracic surgery. The same benefits could be expected from a videoendoscopic surgery involving the thoracic aorta. In 2003 we reported the first case of a totally videoendoscopic descending thoracic aorta-to-femoral artery bypass procedure. In this article we report our additional experience with and the modifications we have made to this technique. (J Vasc Surg 2010;51:1560-3.)

The use of the thoracic aorta as an alternative inflow source for the treatment of occlusive aortoiliac disease has been shown to be safe and effective when an approach to the abdominal aorta is not indicated.[1] The major limitation to this technique is the morbidity rate associated with thoracotomy in a relatively high-risk vascular surgery population. The minimally invasive videoendoscopy procedure has been shown to improve the postoperative course and comfort of patients in general surgery. In thoracic surgery, videoendoscopy reduces postthoracotomy-related morbidity and postoperative pain and allows earlier postoperative mobilization.[2] In vascular surgery for aortoiliac disease, the results of a videoendoscopic approach have been shown to be excellent despite a number of technical difficulties such as exposure of the infra-abdominal aorta requiring bowel retraction, control, and suture of the diseased aorta.[3] Many of these technical limitations could be avoided if aortofemoral bypass originated from the distal thoracic aorta. In 2003, we reported the first case of a totally videoendoscopic descending thoracic aorta-to-femoral artery bypass procedure (TVDTAFB).[4] In this article, we report the modifications we have made to this technique.

From the Department of Vascular Surgery, Clinique Alleray-Labrouste, Paris,[a] Department of Vascular Surgery, Evgenideion Hospital, Athens,[b] Department of Vascular Surgery, Hôpital Privé de l'Ouest Parisien, Trappes,[c] and Department of Vascular Surgery, Centre Hospitalier de Meaux, Meaux.[d]
Competition of interest: none.
Additional material for this article may be found online at www.jvascsurg.org.
Reprint requests: Sumio Fukui, MD, Department of Vascular Surgery, Clinique Alleray-Labrouste, 64 rue Labrouste, 75015 Paris, France (e-mail: sumio_fukui@yahoo.com).
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0741-5214/$36.00

doi:10.1016/j.jvs.2010.01.063

SURGICAL TECHNIQUE

After intubation with a double lumen endotracheal tube, the patient was placed in a supine position, the shoulders were turned to the right lateral decubitus position, and the hips rotated to a more supine position (Fig 1). After lung deflation, a 10-mm port was placed on the anterior axillary line in the seventh intercostal space for the 30-degree angled 10-mm videoendoscopic camera. Two ports were inserted respectively on the midaxillary line in the seventh and eighth intercostal spaces for the working instruments: videoendoscopic scissors and forceps during dissection and needle holders during suturing. A 10-mm port was placed on the anterior axillary line in the fifth intercostal space for suction or traction of the thread during suture. After division of the inferior pulmonary ligament, the lung was retracted superomedially with a traction suture placed through the pulmonary ligament and the thoracic wall.

The surgical procedure was different from the initial technique for the position of the patient and the ports. In a previously published technique,[4] the patient was positioned in a right lateral decubitus position and the ports placed more laterally.

The following steps were similar to both techniques (Video):

The descending thoracic aorta was dissected and controlled. Retroperitoneal access was obtained for tunnelling by making a 1.5-cm muscle splitting incision in the left flank. Finger dissection was performed to the psoas muscle, and then, an open celio 10-mm port was inserted. The retroperitoneum was insufflated with CO_2 and was dissected with the videoendoscope from the inguinal ligament to the diaphragm, passing behind the kidney. Then the retroperitoneum was exsufflated. The groin was exposed, and the site of distal anastomosis prepared. An 8-mm-diameter expanded polytetrafluoroethylene graft (Braun AG, Melsungen, Germany) was inserted into the chest cavity through a 10-mm port. A long curved atraumatic grasper was inserted into the retro-

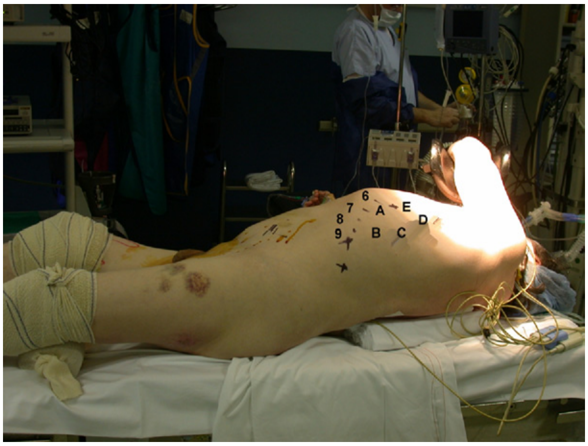

Fig 1. Positioning of patient and sites of port placement. **A,** camera; **B and C,** working instruments; **D,** assistant port; **E,** clamp (*numbers represent respective ribs*).

peritoneum and directed through the posterior attachments of the diaphragm and into the chest cavity under video control. The distal end of the graft then was grasped and pulled down to the left groin. After intravenous administration of nicardipine (Loxen; Novartis Pharma SA, Rueil-Malmaison, France) 0.5 to 2 mg/h to control hypotension at 90 mm Hg of systolic pressure, the aorta was clamped laterally with an endoscopic side-biting Satinski clamp (Karl Storz, Tuttlingen, Germany), which was passed through a 1-cm keyhole chest wall incision in the third intercostal space on the middle axillary line. An end-to-side anastomosis was performed with a 4/0 polypropylene (Ethicon Inc, Somerville, NJ) running suture (Fig 2). After completion of the proximal anastomosis, systemic anticoagulation therapy was administrated (intravenous heparin 50 IU/kg) and the distal anastomosis was performed.

From 2003 to 2008, five patients were scheduled for TVDTAFB. The baseline characteristics, surgical indications, and patient's condition classification are reported in the Table. Anatomical lesions included occlusion of the infrarenal aorta in four cases and unilateral common iliac artery occlusion associated with severe controlateral long segment iliac stenoses in one case. Patient 5 with an ASA 4 classification presented with gangrene of the right toes. He had significant stenoses of the subclavian arteries and the only inflow source without severe atherosclerotic disease was the thoracic descending aorta.

The thoracic descending aorta was chosen as the inflow source because of major calcifications of the juxtarenal and infrarenal aorta in three cases, a history of surgery on the abdominal aorta in one case and a history of major abdominal surgery in one case. Patients 1, 2, and 3 were operated on the initial technique, and patients 4 and 5 on the modified technique. Conversion to a posterolateral thoracotomy was necessary in one case (patient 3) to obtain hemostasis. After the proximal anastomosis had been performed and the aorta declamped, there was a small anastomotic leak. Aortic cross-clamping was necessary to control bleeding and conversion was preferred to avoid prolonged ischemia. Peroperative data are reported in the Table. At discharge, computed tomography (CT) angiography (Fig 3) demonstrated that all patients had a patent bypass without stenosis. One patient died 18 months after surgery from a cerebral tumor. The aortofemoral bypass was patent. The three remaining patients were alive with a patent bypass 58, 24, and 17 months postoperatively.

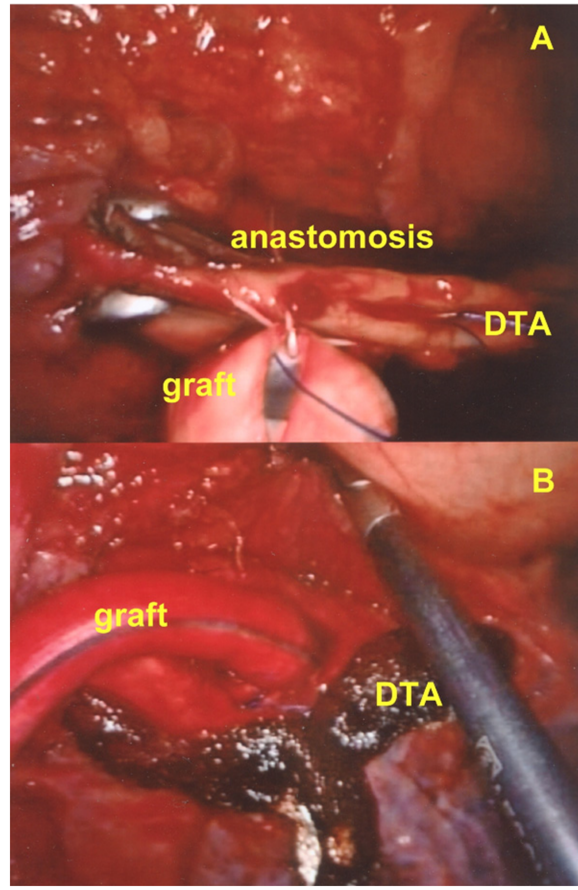

Fig 2. Peroperative view. **A,** Side clamping of aorta and anastomosis**. B,** After release of aortic clamp. End-to-side anastomosis of graft on descending thoracic aorta. *DTA,* Descending thoracic aorta.

DISCUSSION

The feasibility of TVDTAFB has been shown in several experimental studies.[5,6] In humans, the videoendoscopic technique was associated with a minithoracotomy to perform anastomosis with direct vision or to serve for inserting the side-biting clamp.[7,8] In 2003, we reported the first TVDTAFB with the clamping and the suturing performed without the adjunct of a thoracotomy.[4]

Since this publication, laparoscopic surgery has resulted in numerous improvements in the laparoscopic treatment

Table. Preoperative and peroperative data

Patient number	*Age/gender*	*ASA score*	*Symptoms*	*BMI*	*Conversion*	*Procedural time*	*Clamping time*	*Distal anastomosis*
1	58/male	3	Claudication	21	No	390	90	Pre-existing femoro-femoral bypass
2	68/male	2	Claudication	22	No	370	120	Pre-existing femoro-femoral bypass
3	53/male	3	Claudication	20	Yes	400	90	Left common femoral artery
4	57/male	3	Rest pain	21	No	330	73	Left common femoral artery
5	57/male	4	Gangrene	24	No	270	90	Right common femoral artery

ASA, American Society of Anesthesiologists; *BMI,* body mass index.

Fig 3. Control computed tomography (*CT*) angiography: descending thoracic aorta to femoral artery bypass.

of abdominal aorta disease and a corresponding increase in the number of reported series.[3] However, there were no published series on TVDTAFB. One case of a minimally invasive robot-assisted procedure for descending aorta-bifemoral bypass has been reported.[9]

A robot and thoracoscopic techniques were used for exposure and the anastomosis. However, the patient developed postoperative paraparesia from cross-clamping and spinal cord ischemia.

Lateral clamping of the thoracic aorta can be beneficial to limit hemodynamic effects and increases in vascular resistance and to maintain perfusion below the aortic clamp minimizing spinal cord, renal, and visceral ischemia. This may explain why patient 5, who was especially fragile, tolerated this procedure well.

Although we have extensive experience in laparoscopic surgery of the abdominal aorta (60 cases of totally videoendoscopic treatment for aortoiliac disease), we did not significantly reduce aortic clamp time during TVDTAFB. Aortic clamping time is much less important with lateral clamping, allowing the surgeon to perform the anastomosis carefully and comfortably. However, even with careful and time-consuming anastomosis, patient 3 developed a leak, which we were able to control after cross-clamping, leading to conversion. We suggest the following maneuver to avoid cross-clamping in case of bleeding: an occlusive balloon is inserted through the graft to control bleeding, making lateral clamping and suturing possible again. This maneuver (cadaver study) might be especially beneficial in high-risk patients when cross-clamping is not recommended.

Clamping safety is another major concern. With this entirely videoendoscopic technique, clamping is only controlled with the view on the screen. Kolvenbach[8] experienced dislodgement of the clamp in one case. He placed a second conventional clamp through the same minithoracotomy. Nevertheless, new videoendoscopic aortic clamps have been developed. These clamps have many different designs: curved, straight, and side-biting. They have been designed specifically to be placed through a cutaneous 1-cm incision with the CO_2 tightness assured without the necessity of a port during laparoscopic vascular procedures. These clamps are as powerful and safe as a conventional clamp. Straight clamps can also be inserted through a 10-mm port so that an immediate clamping can be performed in case of a dislodgement of the side-biting Satinski clamp.

Dissection of the aorta in the chest cavity is simple because few surrounding structures are present. The potential complications and morbidity associated with trauma of the small and large intestine, ureters, and iliac veins during the exposure of the aorta are completely avoided. The aortic exposure can be limited by the presence of pleural adhesions, which can lead to pulmonary trauma.[10]

We changed the position of the patient for two main reasons: first, in the right lateral decubitus position, the working instruments are placed perpendicular to the operating table. In the modified technique with the patient in a supine position, the working instruments may be placed in a horizontal position resulting in a more ergonomic and natural interface. The second reason is that the right femoral triangle cannot be exposed in the right lateral decubitus position so the patient has to be changed to the supine position after proximal anastomosis is completed.

We chose the right lateral decubitus position at the beginning of our experience to allow fast conversion to a posterolateral thoracotomy and to obtain complete exposure of the thoracic aorta. However, in the modified position, exposure and control of the distal thoracic aorta is possible with conversion to an anterolateral thoracotomy through the seventh intercostal space.

Tunnelling in conventional descending thoracic aorta-to-femoral artery bypass is usually a "blind" procedure. In our case, videoendoscopy provided visual control of retroperitoneal tunnelling, preventing any wrong directions which could cause iatrogenic trauma.

Although this report presents a small series of patients, TVDTAFB seems to be a safe and effective procedure even in high-risk patients with good midterm results. Further evaluation is necessary to confirm the potential advantages of this technique.

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Submitted Dec 11, 2009; accepted Jan 22, 2010.

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